



# Carbon Commentary Newsletter #5

*A critical appraisal of issues in the move to a low-carbon economy*

Monday 12 November 2007

Carbon Commentary covers financial, social and political aspects of the drive to limit climate change.

In this edition I write about two reasons for substantial optimism: a new \$200m US venture to get electric cars off the ground and the increasing excitement over the potential of charcoal to sequester carbon. Hillary Clinton's climate change proposals are an indication the global warming is becoming an important political issue in the US. The BBC World Service survey on climate change opinion shows that the Chinese are at least as interested in doing something as people in the UK. E.ON's consumer segmentation gives important information about UK consumer attitudes.

An article on the rebound effect looks at whether improvements in energy efficiency generate counter-balancing increases in energy use. A final piece looks at two recent natural disasters in California and Mexico and assesses the strength of the evidence that climate change is to blame, concluding that public policy failures are at least as important.

Chris Goodall

[chris@carboncommentary.com](mailto:chris@carboncommentary.com)

Chris Goodall will be speaking at the Marketing Society conference on 20 November at the Royal Opera House. Jonathan Margolis discusses some of the counter-intuitive findings from his book *How to Live a Low-Carbon Life* in the *FT* of Saturday 17 November.

## Articles in this edition

[Shai Agassi and the big batteries](#)

[Hillary Clinton's climate change plans](#)

[Public opinion on climate change](#)

[The rebound effect](#)

[Biochar can sequester carbon cheaply](#)

[Natural disasters and global warming](#)

## Shai Agassi and the big batteries

Shai Agassi, the California-based software superstar who wanted to run SAP but left the company in March when he didn't get the top job, has come back into the spotlight as the CEO of an electric car start-up. The new company is funded by \$200m of venture capital and investment bank money. This makes it one of the best-funded start-ups in history.

Agassi does not intend to make electric cars. Wisely, he is leaving this to the auto industry. He is focusing on the batteries. He'll lease them to anybody with an appropriate car and he'll develop large networks of 'filling stations' where the driver can quickly take out a discharged battery and swap it for a fully charged version on long journeys. By 2010, he wants a hundred thousands electric cars on the roads of California and elsewhere.

The obstacles are huge. Although lithium-iron-phosphate battery technology is



improving rapidly, and will continue to do so for decades, full-size car batteries now cost at least €7,000. Getting mainstream manufacturers to build large volumes of electric cars that will take his batteries is another formidable challenge. Third, he has to persuade retailers to install the equipment to swap batteries automatically.



But our weary European scepticism needs to be rested for a moment. The long-run economics favour this idea. My sums suggest that at current UK petrol prices it costs at least six times more to drive a mile on petrol than it does on electricity. Battery prices will fall and performance will improve. At some point it is going to be so much cheaper to power a car with electrons rather than octane that even the slothful auto industry will switch. When the market has tipped it won't be long before passenger cars are all electric. Agassi may be too early, and his business model may require too much capital, but electric cars are coming soon.

\*\*\*

GM designed an electric car in the 1990s. Several hundred EV1s were built and leased to generally enthusiastic owners. The cars were costly for GM to build, had a range of only 60 miles or so, and took a long time to recharge. The company abandoned the project and crushed all the cars.



Probably as a result of the perceived failure of the EV1, the idea of the all-electric car lost momentum. Attention switched to petrol-electric hybrids, such as the Prius, and the hugely eccentric idea of hydrogen fuelling. Conventional hybrids do not take electricity from the mains to power the car; they use petrol for much of the time. Energy is captured from the braking process and stored as electricity in an on-board battery to power the car when at low speeds.

More recently, engineers and car companies have started to investigate recharging the batteries of hybrid cars using mains electricity. These so-called 'plug-in hybrids' use electricity most of the time, particularly for town driving, and only have a petrol engine for long-distance travel or when recharging is impossible. The article on [Hillary Clinton's climate change plans in this edition of Carbon Commentary](#) refers to her enthusiasm for plug-in hybrids. She also sees them as an important asset in smoothing the power needs of local electricity grids. When community demand is high and batteries are fully charged, the grid will start co-opting power from cars parked in driveways but connected to the mains.

Most major automobile manufacturers have development programmes for hybrid cars. Technological progress continues to be slightly disappointing. Light diesel cars now have CO2 emissions that match the Prius, although the Toyota car offers far greater comfort and is a more potent status symbol among the urban elite.

Small but increasing numbers of purely electric cars are being sold in the UK. The G-Wiz is increasingly visible on London streets, not least because it is taxed as a quadricycle, not a 'proper' car. The UK retailer says that it sells 'one or two a day' in London. 900 out of the 2,000 G-Wiz cars in the world are driven around the city, free of any congestion charge, and with electricity top-ups in some central London car parks. The range of the car is about 70 miles with a top speed of 45mph, though with commendable honesty the retailer stresses that it should probably be kept on congested, and slow-moving, urban roads. In fact, the average speed recorded by G-Wiz cars in London is a sedate 10mph.

Smart is just about to launch an electric version of its existing cars. Press comment suggests that the new Smart will manage a top speed of about 50mph and last for 70 miles between charges. At about 5 hours, charging time is still depressingly long.

The engineering of all electric cars is moving fast. Several models are slated for launch in the States that can manage far higher top speeds and longer cycles between charging. The Tesla is an expensive (\$100,000) sports car that claims acceleration better than a Porsche at the same time as fuel costs of less than 1p per mile. The manufacturer claims that the lithium ion batteries are fully charged in three and a half hours and deliver a range of 245 miles. The marketing of this beautiful car glorifies speed – a far different approach to the virtuous but slightly dull retailers of cars like the £8,000 G-Wiz.

### **So what is Shai Agassi trying to do?**

The detail on Agassi's scheme is sparse. The idea is to set up a network of sites, powered by solar energy at which drivers can swap batteries. The driver never owns the battery, but leases the right to have one in his or her vehicle. Most of the time, the car user will not need to switch batteries. They will usually be charged overnight at home, or during the day at the workplace, through ordinary domestic power sockets.

He has raised \$200m from venture capital sources and from Morgan Stanley. One of the key investors is Vantage Point Ventures, also a backer of Tesla cars. For a start-up company, an injection of \$200m is a huge sum of money, but the capital needs of a business like this are going to be phenomenal. At today's prices, each battery costs €7,000, and if the entire sum raised were used to buy batteries, it could only equip a few tens of thousand cars. But of course the money won't all go to buying batteries. This task – essentially a conventional leasing activity – will be taken on by Morgan Stanley once the business model is proved. Agassi's venture needs the money to begin to build a network of re-charging sites.

The wisdom of the electric vehicle industry has always been that the battery is part of the car. Agassi says that drivers need not own the battery. The battery is the gasoline of an electric car, and you buy gasoline when you need it, not when you first buy the car. This is the key insight – removing the cost of the battery from the purchase price will bring the vehicle cost down, eventually to a lower price than the equivalently specified car. An electric vehicle doesn't need an expensive engine and a troublesome transmission system. There may be as few as a dozen moving parts.

Crucially, Agassi believes that the auto industry is about to tip away from gasoline and towards electric power. His theory is based on three elements:

- The price of oil is going to go up. 'Peak Oil' is here.
- The operating characteristics of batteries for electric cars are all moving favourably. Cost and weight are down. Power (think of this as the capability to accelerate a car) and storage capacity (the distance you can drive) are going up.
- Third, the cost of renewable technologies to generate the electricity for the battery is also falling fast.

### **The price of oil is going up**

The world oil market can't quite understand what is happening to the price of a barrel. Industry experts mutter crossly about an unwarranted speculative premium. Nevertheless, the \$100 hurdle looks as though it may be crossed, taking the oil price to a level not seen in real terms since the 1970s. Part of the reason that Agassi's plan attracted substantial attention in the US is that the country is rattled by the spike in the price of this most vital of American commodities. In the UK and elsewhere, our interest in the price of oil is muffled by the falling value of the dollar and the limited impact seen so far at the petrol station.

In the 1970s the very high price of oil (even more important to the economy then than now) pushed politicians and auto companies into improving fuel economy standards. The fuel economy performance since the late 1980s has barely changed in the US. The increase in the price of gasoline may push automakers and consumers into more efficient models. This would tend to mute the future interest in Agassi's scheme but the reaction times of Detroit seem to exceed those of any other major industry in the world.

### **Batteries are getting better**

The early electric cars were powered by lead acid batteries, the technology still used for starter motors in most vehicles. They were superseded by nickel metal hydride batteries. Recently, the industry began to experiment with lithium ion, the same technology that powers laptops and mobile phones. The performance has improved markedly, but concerns persist over the safety of large lithium ion arrays. It is not long since we had an outbreak of exploding laptop batteries and conventional lithium iron cells can, in theory, release a huge amount of heat very quickly.

Agassi is going for the next step up – lithium iron phosphate batteries. Here the risk of catastrophic malfunction is lower, although the performance is slightly less good than conventional lithium ion. Companies like Lithium Technology Corp already make car-sized agglomerations of lithium iron phosphate batteries. This company claims it can produce a 25 kWh battery weighing 200kg that would take a car 160 miles.

Agassi's venture is reliant on what he sees as the Moore's Law of battery improvements: a 50% decline in cost per kWh every five years. It seems a reasonable assumption to make. The industry is bullish it can achieve better performance with lithium iron phosphate and large amounts of US government money are being ploughed into companies in the field.

### **The costs of renewables are falling**

Agassi's venture is vague on the third leg of the business case. It seems that he believes that the company will need to invest in large numbers of sites that recharge batteries. Drivers straying from their home or workplace will need access to fully charged cells. In California, his company can use solar electricity for the task of recharging. I am sure Agassi is right that the cost of solar photo-voltaic installations are likely to fall at least as fast as the cost of batteries. Within five years we are likely to see very substantial improvements in the price per watt as advances in silicon nanotechnology allow PV panels to be made from paper-thin silicon, rather than the expensive blocks of today.

Why does he need to recharge the batteries using solar energy? What is wrong with simply plugging into the conventional electricity distribution system? The answer seems to be that he is concerned that the Californian power

grid is simply not robust enough to provide even the very limited amount of power that is likely to be needed. Frequent summer 'brown-outs' might make it impossible to obtain enough power.

The big problem is going to be the size of the solar installations necessary to recharge a bank of tens of batteries. Very approximately, current technology needs a square metre to collect a kilowatt. A battery needing 25 kWh of charge over a period of five hours would be taking 2.5 kW. Even at the middle of the day, when the panels will be working at full capacity, one battery will need almost 30 square metres of PV panels. Charge fifty batteries at the same time and you need the whole roof of a large commercial building. (Advances in solar PV technology will lower the cost, but may not decrease the surface area needed to generate electricity.)

In my view, the real reason why solar energy is part of the current plan is that Agassi needed a software component to the business plan to show why he, an SAP veteran, should run an automobile venture. The press statements make play of the software needed to run the 'grid' that he plans to link the recharging sites. I think that this is nonsense – the sooner he drops the idea of solar PV on every recharging point the better. It adds to the complexity and difficulty of the business. If solar energy makes financial sense in five years, then he can build a huge central facility to 'offset' the amount used to charge the batteries. To build solar-powered charging stations now is unlikely to make sense, and significantly raises his overall capital need – never a good idea in a start-up.

#### **Does the idea make sense?**

If a 25 kWh battery can propel a car for 160 miles, then at current UK retail electricity prices, the fuel cost is 1.5p per mile. For a typical family car, the petrol cost may be close to ten times this level.

The average UK car does about 9,000 miles a year. (The figure is much higher in the States.) The petrol cost is about £1,000, compared to less than £150 for a car whose battery is always charged at home at standard UK electricity prices. The fuel cost advantage is clear, at least in countries with high-price petrol.

What about the cost of the battery? At €7,000 (Agassi's figure), the pay-back period would be about six years, if the cost of the battery were entirely additional. If, instead, the cost of the car were reduced because it no longer needs an engine or transmission, the economics may become really compelling. They are likely to become more so as time passes.

There is thus only one real question: can the famously persuasive Shai Agassi get volume car makers to build cars with no internal combustion engine, but with an electric motor and a hole where the battery goes? The chances of Detroit starting to eat its own lunch seem remote, but Asian car-makers may grasp the opportunity gratefully.

#### **What is the effect on emissions of moving from petrol to an electric car?**

A typical UK car produces about 180g of CO<sub>2</sub> per kilometre. (Remember that an internal combustion engine is only about 25% efficient at turning chemical energy into motion.) An electric car with an advanced battery running on a charge from the UK grid will have responsibility for average emissions of about 35g per kilometre, or about one fifth as much.

#### **Why not the UK, rather than the US?**

Many UK cars never travel on long trips. Petrol prices are almost double the US figure. When charged at night, some drivers could benefit from the extremely low overnight power prices on dual-rate tariffs. Electric cars are exempt from London's congestion charge (£8 a day). And, eventually, wind power can be used to charge the batteries at the refuelling stations on major roads. If Agassi's idea makes sense in California, it has very compelling economics here.

## **Hillary Clinton's climate change plans**



The US presidential contenders are laying out their plans for climate change mitigation and adaptation. Mrs Clinton's proposals are noteworthy for their commitment to re-engage with the global negotiations over future emissions caps and for her ambitious acceptance of the need for an 80% reduction in US emissions by 2050. The 80% target is rapidly becoming the preferred option of world politicians, a more ambitious target than the UK's 60% figure. (The UK's Climate Change bill will allow the new Climate Change Committee to recommend an increase to 80% if appropriate.)

Mrs Clinton espouses a cap-and-trade system for US emissions. Unlike the EU's approach, she proposes to auction the permits. She will continue the disastrous US policy of encouraging the



conversion of corn to bioethanol. She looks to renewable electricity to provide 25% of US power.

She will add to federal expenditure on R+D, but the number proposed is insufficient to have much effect. She stresses the high cost of energy (gas, motor fuels and electricity) to American citizens but not does mention that the impact of her measures will be to increase energy costs, not reduce them.

Mrs Clinton's plan is calm and measured. Contrast her statesmanlike tone with David Crane, the CEO of a large electricity generating company, in a 14 October article in the *Washington*

*Post*. Crane writes, 'We are not running out of time, we *have* run out of time' [his italics]. He argues that the US government should put an immediate price on carbon emissions to incentivise a rapid switch to carbon capture and storage in the US power sector. His tone is desperate: 'I am a carboholic' but I want to stop, he writes. We could all do with a similar sense of urgency from Mrs Clinton.

\*\*\*

**Cap-and-trade**

*What she says*

Cap-and-trade systems such as the European Emissions Trading Scheme allocate permits to polluters. Clinton will introduce a similar scheme in the States. In the EU, the permits are largely handed out free to the major CO2 producers. Clinton says she will auction the permits and use a small part of the revenue for a new R+D fund.



*What she doesn't say*

- 1. There's no indication of much of the US economy she intends to cover. In the EU, the scheme takes in about 50% of total greenhouse gas output.
- 2. Similarly, she offers no clue as to how tight the cap will be. For example, she might have said that she would auction permits for 2bn tonnes of CO2 output across industries that currently produce 2.5bn tonnes. Nor does she say how fast she will reduce the allocation.
- 3. She gives no indication of how much revenue she expects.

**Electricity consumption**

*What she says*

She will introduce measures that will reduce energy consumption by 20% below the forecast figures for 2025. 25% of electricity will come from renewable sources. She offers no encouragement to the nuclear industry.

*What she doesn't say*

- 1. A 25% reduction in electricity consumption will still leave electricity use slightly higher in 2025 than it is today.
- 2. If 25% of electricity is to come from renewable sources, then 70% of the investment in power generation from today onwards will have to be devoted to non-fossil fuel technologies. There is no current sign of this happening and a major change of direction will be required.
- 3. The US Energy Information Agency (EIA) suggests that a target of 25% renewables will add about 6% to electricity prices. The Clinton plan doesn't mention this.

**Renewable Fuels**

*What she says*

Her target is '60bn gallons' of ethanol and bio-diesel. She intends to set a target that will oblige biofuels producers to show that each gallon of biofuel uses 80% less fossil fuel in its cultivation and manufacture.



*What she doesn't say*

- 1. 60bn US gallons is approximately 25% of motor fuel use by 2025, according to Energy Information Agency projections. The number of miles travelled in 2025 will be about 40% greater than today, if EIA forecasts are correct. Therefore, even this volume of biofuels will not by itself reverse the need for rising oil consumption.
- 2. There is no mention of the impact on prices, either of fuel at the petrol pump, or of agricultural commodities.

In a document from earlier this year, the EIA (a part of the US government and thus not necessarily opposed the expansion of biofuels) said that the target chosen by Mrs Clinton would result in a doubling of corn prices. If made from corn, the biofuels would require about 80% of today's total US crop.

3. The target for improving the fossil fuel efficiency of making biofuels is highly ambitious. At the moment, the fossil fuels savings from manufacturing biofuels are extremely limited. To get to the point at which 2 units of fossil fuel are used to make 10 units of bioethanol requires technical advances beyond those that can currently be envisaged. The current boom in ethanol production is adding noticeably to natural gas demand as plants need heat and power to turn corn starch into a useable fuel.
4. Bioethanol is heavily subsidised. According to the EIA it will not be cost-competitive until 2015. So Mrs Clinton's plan will either raise fuel prices or require more federal subsidy. This point is not discussed.

### **Fuel efficiency standards for automobiles**

#### *What she says*

The failure to improve the fuel efficiency of US cars over the past fifteen years is one of the most damaging failures of national policy. Mrs Clinton looks to more than double economy standards by 2030. She rails against 'the untenable foreign trade situation in which the United States transfers funds that are borrowed from China to Saudi Arabia' to pay for its oil.

#### *What she doesn't say*

The proposed standards only bring the US fuel economy standards in 2030 to approximately the level today of the best European and Asian cars.

### **R+D**

#### *What she says*

\$5bn a year will be spent on energy research and development, a multiple of what is spent today. Money will largely come from the oil companies. She says that they need 'to do their share in funding clean energy'.

#### *What she doesn't say*

Total Federal funding of R+D is about \$140bn a year, of which the bulk goes on defence-related projects. NASA gets over \$12bn to plan, *inter alia*, for future trips to the moon. Alternative energy research in Mrs Clinton's administration is to get less than 40% of this particular allocation.

### **'Smart grids' in large cities**

#### *What she says*

Mrs Clinton looks forward to the creation of 10 'smart grid' cities. These cities will invest in technologies for reducing and smoothing the demand on electricity generators. She wants to implement technologies that allow electricity pricing to vary according to the level of local demand. She is keen on using the batteries of 'plug-in' hybrid cars to return power to the electricity grid when it is in short supply. (For more details on electric cars, please see the article on [Shai Agassi in this edition of Carbon Commentary](#).)

She says that demand reduction programmes can reduce total demand by 5%.

#### *What she doesn't say*

She suggests that using the batteries of cars will provide \$2,000-\$4,000 a year of income to hybrid car owners and be an important means of avoiding costly peaks in demand, particularly during the air conditioning season. This is an unrealistically large figure and could only conceivably be achieved if the large batteries of an all-electric car were discharged and recharged several times a day at times of high and low prices respectively. This is impossible, even in theory.

### **Other main points**

She argues for:

1. A federal mortgage bank to provide loans for energy efficiency improvements.
2. A major attempt to improve the energy efficiency of the 20m worst insulated homes.
3. A job training programme to equip 100,000 people with the skills to install and maintain low-carbon technologies and energy efficiency measures.
4. Investment in public transport (the sums mentioned are utterly derisory).
5. 10 large carbon capture and storage projects. The UK has proposed one.
6. Improved energy efficiency standards for home appliances. The US Energy Star programme has been effective and robust. There is great merit in tightening standards and making them apply to a wider range of standards. But energy efficiency is currently fighting a losing war against the expansion of the number and size of appliances in US (and European) homes.

Mrs Clinton's plans are evidence of the growing seriousness with which global warming is treated in the US. Some of her proposals are good and will use sensible market mechanisms to reduce energy use below what it might otherwise be. But the reader of her climate change proposals is left with the feeling that the measures were thrown together without much careful thought, and certainly not with any acknowledgement that cutting emissions 80% in 40 or so years is a difficult and painful task.

## Public opinion on climate change



Two pieces of market research published in the last week give some more support for the view that opinion is moving towards accepting that climate change will require lifestyle changes. BBC World Service interviewed individuals across the globe. Power company E.ON produced its segmentation of British consumer attitudes.

The BBC survey suggested that over 80% of UK people are 'ready to make significant changes in the way I live to help prevent global warming'. Nearly 90% think that changes in lifestyle will be necessary to address the problem. These numbers are approximately the same as among urban Chinese and only marginally higher than the US.

E.ON's segmentation has over 20% of the UK already taking serious and possibly costly personal action related to climate change. Less than 15% actively reject any need to act now.

\*\*\*

BBC World Service recently published the results of a large worldwide survey on climate change issues. It gathered data from over 20 countries but the results I write about in this section are from the US, urban Chinese and UK responses. For clarity, I have generally grouped the responses into percentages that 'agree' or 'disagree' although respondents will have usually been offered a wider range of options. I have omitted 'don't knows'.

### Human activity is a significant cause of global warming

	US	China	UK
Agree	71	87	78
Disagree	24	11	17

More people in China think that human activity is responsible than in the UK or the US.

### Is it necessary to take steps to reduce the impact of human activities?

	US	China	UK
Major steps	59	78	70
Modest steps	33	16	25
Not necessary to take steps	6	4	3

The Chinese are more inclined to believe it is necessary to take major steps to do something about climate change. In the UK and the US, the percentage of people saying nothing needs to be done is well below the percentage of 'deniers'. Many of the sceptics still want to do something. This is not irrational. We insure our houses even though the chance of damage is tiny.

### Developing nations should not be expected to limit their emissions

	US	China	UK
Agree	18	27	25
Disagree	75	68	70

A large majority in China agree that developing nations should limit emissions. The other countries also have a strong view that developing countries need to bear some of the burden.

### To encourage individuals to use less, the costs of energy should be increased

	US	China	UK
Necessary	65	83	77
Not necessary	32	14	20

Even in America there is a two-to-one majority in favour of increasing the price of carbon-based energy.

### Changes in lifestyle and behaviour are necessary to reduce global warming gases

	US	China	UK
Necessary	79	86	87
Disagree	19	12	12

The view that lifestyle changes are necessary is more strongly held than that carbon-based energy prices should be increased.

### Taxes on carbon fuels should be raised

	US	China	UK
Favour	46	85	54
Oppose	51	13	42

The Chinese are much more in favour of using taxes than the UK and US. In the UK and US these numbers are substantially below the percentages of people who think that is necessary to raise energy prices.

In some further questions those opposing tax increases were asked whether using the money to support renewables and energy efficiency would change their view. About half of the opponents in the UK and US changed their mind to support higher taxes in these cases.

### Ready to make significant changes to the way I live to help prevent global warming

	US	China	UK
Agree	76	83	81
Disagree	22	14	16

About 80% of people are prepared to make significant changes to lifestyle. The percentages 'strongly' agreeing with this statement were 43% in the US, 47% in China and 37% in the UK. The percentage of people apparently really committed to doing something is lowest in the UK, though still a large fraction of the population. This is consistent with the results from the [HSBC poll reported on in an earlier edition of Carbon Commentary](#).

### The overall conclusions from the BBC survey

Opinions vary across the world, but a clear majority is in favour of the view that humankind is responsible and that lifestyles will have to change to meet the challenge. There is no evidence to support the view that people in China are any less prepared to bear some burden than respondents in the UK and US.

### The E.ON survey

E.ON published a long document summarising several pieces of research it has carried out this year.



### Children's views

The report looks first at the attitudes of children and young people to climate change, showing a higher degree of concern than among older people. Paul Golby, CEO of E.ON UK, writes:

'Not only are children most worried about global warming and climate change...but they are also convinced we won't be able to solve the problem for them.'

73% of children believe that all energy should come from renewable sources. 69% 'believe that they have a responsibility to encourage others to recycle and save energy'.

My interpretation of E.ON's commentary is that levels of knowledge about climate change are surprisingly low, but there is a substantial degree of generalised anxiety about the problem.

## Adult segmentation

The second issue of *Carbon Commentary* carried an article on the results of segmentation studies by Henley Centre and Marks & Spencer. M&S sees the following segments:

- **A:** Green zealots: people who will actively seek out the most ethically and environmentally responsible products. Climate change is particularly important issue to these people.
- **B:** Those interested and concerned, but often uncertain how to shop to achieve their ethical objectives.
- **C:** Aware of the problem, not certain that their actions can have much effect or that they need to shop differently.
- **D:** Struggling, do not give high priority to issues covered in Plan A.

The company assessed the percentages in each segment as follows:

Group	Now	3 years ago
<b>A</b>	5-10%	3-4%
<b>B</b>	30-35%	about 15%
<b>C</b>	30-35%	about 50-60%
<b>D</b>	25-30%	25-30%

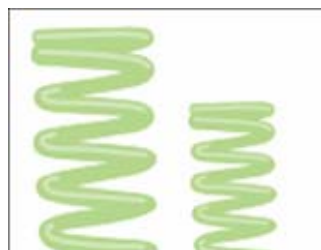
E.ON cuts the population into five types, not four:

- **Type 1:** 'Clued up about environmental issues and recognises the direct impact the UK's energy consumption has on climate change.'
- **Type 2:** 'They believe people are damaging the environment and are taking some tentative easy steps to reduce their impact.'
- **Type 3:** 'This segment seems happy for others to save the planet, with their support. They have taken few, if any, steps themselves.'
- **Type 4:** 'The issue is generally not that important to them.'
- **Type 5:** 'They disagree that humanity is to blame for climate change...They don't recognise any need to act now.'

Type 1	Type 2	Type 3	Type 4	Type 5
22%	25%	22%	18%	13%

Types 4 and 5 seem very similar to Marks & Spencer's group D: both with about 25-30% of the population. These people will not be receptive to marketing offers that focus on the climate change benefits of a product or service. Type 1 is an extended version of M&S's group A, less committed than the 'zealots' of A, but still well informed and worried. Type 1 people will respond well to green offers. The marketing challenge will be to get people in Types 2 and 3 to match their concerns over climate change with purchasing decisions that match their own attitudes.

## The rebound effect



Energy efficiency improvements often do not deliver reductions in energy use. For example, when a householder installs better insulation, the energy savings are sometimes much less than would have been predicted. Sometimes this is because the insulation was badly fitted, but it is often because the householder runs the heating at a higher temperature when the house is better insulated. This is called the 'rebound' effect: when it becomes cheaper or more effective to use energy, people use more of it.

The many studies into this effect have produced a wide variety of different estimates for the size of this effect. Most cluster between 10 and 30%. This means that energy efficiency improvements generally result in a large net benefit. But these studies only capture the direct effect on consumers and businesses. A study from the UK's Energy Research Centre shows that the economy-wide impact may be much larger. For example, lower heating bills may mean that householders are rich enough to take more flights. At an even higher level of abstraction, better economy-wide energy efficiency (through, say, improvements in steel-making technologies) may encourage more rapid economic growth, which in turn raises energy use.

Some economists think that the economy-wide rebound from energy efficiency gains is very large – perhaps over

100%. A figure over 100% suggests that total energy consumption rises after energy efficiency improvements. The tentatively stated view of a new report by the UK Energy Research Centre is that the true number is somewhat lower than this and may be around 50%, although it could be a great deal higher.

Government projections for the impact of energy saving measures never take the rebound effect into account. Policy-makers trying to reduce global emissions need to adjust their thinking to reflect the much lower than expected efficacy of energy saving programmes.

\* \* \*

For several decades economists tended to believe that as societies grew richer, they improved energy efficiency and consumed fewer goods that took large amounts of fossil fuel energy to make. This seems a reasonable view: in most industries the productivity of energy use is improving, often at 2% or more a year. Similarly, developed societies are tending to reduce the fraction of carbon intensive products in their national income. In the rich world we need less and less steel and concrete for each extra unit of GDP.

Nevertheless, energy consumption continues to rise quite strongly. [The last edition of Carbon Commentary suggested that after adjusting for the effect of the growing trade deficit with China, UK CO2 emissions are rising as fast as GDP.](#) There is, in fact, no obvious 'decoupling' of growth and energy use.

This is an extremely serious issue. If growth in the richest countries continues to require big increases in energy use, we can be almost sure that the position in developing states is even worse. Continued growth in these countries will probably embed very rapid increases in energy availability. Indeed, the evidence is that the growth in world energy use is running at more than 3% a year, substantially higher than forecast in the central IPCC models. The rebound effect – direct and indirect – may be an important part of the reason.

#### **Direct rebound effects**

Studies – usually by engineers, not economists – routinely note that energy efficiency improvements do not result in the expected reductions in energy consumption. The most quoted case studies report on home heating:

- Insulation improvements make it cheaper to heat a house. So homeowners run the thermostat at a higher level.
- Efficient central heating boilers make it easier to heat every room, and not just the living areas.

The direct rebound effects of better heating efficiency are probably between 10 and 30% in advanced countries. The Energy Research Centre paper suggests that there will generally be bigger effects in poorer households. Three years ago, when fuel prices were at their cheapest, the top 30% of UK households were said to devote an average of 1.3% of their total expenditure to gas and electricity. The rich already run their whole house at 21 degrees in winter, so a better boiler does not increase heating levels.

But poor pensioners previously lacking the money to heat the house properly will often take the benefit of cavity wall insulation in higher internal temperatures. Studies of poorer households around the developed world usually show some households actually increasing their energy use after insulation has been installed. For these people, the rebound is greater than 100%. Assistance targeted to those in 'fuel poverty' sometimes produces very disappointing results if energy saving is seen as the main objective. On the other hand, the impact on internal temperatures can be profoundly beneficial. The UK government's 'Warm Front' insulation programme claims a 2.8 degree increase in bedroom temperature among the 'fuel poor', taking the level above the minimum 16 degrees recommended for respiratory health.

The same results can be seen in transport use. Improvements in the fuel efficiency of cars do seem to leak through into greater car use. Checking on causality is very difficult: does someone buy a new car and then use it more because it is cheaper to run, or did they buy the car because they expected their travel needs to increase? Did the purchaser buy a car with a slightly bigger engine than they would otherwise have done because fuel economy standards have improved? We cannot easily tell. Nevertheless, some – probably small – part of improvements in fuel efficiency seems to be taken back in greater petrol use.

In many areas of life – not just domestic temperatures in winter or in the car we buy – we routinely trade-off energy costs with our time or our comfort. If it is cheap to drive the car to the supermarket, we are more likely to do so. If drying clothes is a chore, then as we get richer we are more likely to use the tumble dryer. These effects are enhanced by growing energy efficiency, but the rebound is likely to be greatest among poorer groups.

This point is doubly true in developing countries. There, a family may spend a large portion of its entire income on fuel. All available cash goes on kerosene to power a water pump or light the house. The efficiency rebound effect is very likely to be much greater. The (largely anecdotal) commentary on this issue regularly reports that families will increase their energy use dramatically when efficiency is improved. Their need for greater access to energy is so great that the rebound is nearly 100%.

Does the direct rebound effect spread to home appliances? Do we, for example, buy bigger fridges because the energy efficiency of a good refrigerator has doubled in the past ten years? Or do we open the door more often and for longer periods? The evidence is fairly clear that the impact of better fridges is quite small. And even an inefficient fridge only costs £35 a year to run. Few people seem to adjust their behaviour to buy bigger devices as they become better at using electricity. Energy is too cheap for this to have much impact.

So these are the direct rebound effects: greatest in home heating (and cooling) at perhaps 30% for poorer households in the rich world and 10% for the richest homes, less in the case of personal transport in the developed world and negligible in the case of home appliances, but almost certainly higher for all types of energy use in less well-off countries.

All other things being equal, the direct rebound effect is likely to diminish as we become satiated with energy use. The rich person buying a new car doesn't drive it more because it has slightly better fuel economy than his last automobile. The future for indirect rebound effects is much less clear and possibly far less optimistic.

### **Indirect rebound effects**

Early in the industrialisation process, indirect rebound effects were often greater than 100%. To give the most obvious example, the invention of the steam engine, an efficient new way of turning fossil fuels into motive power, increased rather than diminished total energy demand. It did this in two ways: it made it relatively cheaper to use machines rather than human labour and it indirectly caused the economy to grow. The declining real price of valuable energy has been one of the most powerful impetuses generating economic growth, and perhaps this is where the real worry lies. There are two particular concerns which policy-makers need to focus on:

- The indirect impact of improving energy efficiency on consumption patterns.

As energy efficiency improves, we need to spend less and less of our income on the energy embodied in our goods and services. In 1984, the typical household spent 6% of its income on fuel and power. By 2005, this had fallen to 3%. The other major decline has been in food and drink costs, partly as energy efficiency has improved in the industries supplying us. This has given us spare money to spend on other things, and personal travel and consumer electronics have taken a good share of this extra cash. 'Leisure services' now account for 14% of a much larger household income compared to 7% in 1984. As we have got richer, a large fraction of our incremental income has gone on holidays abroad, more TVs, and greater car travel. This is an indirect rebound effect from better energy efficiency. We are choosing to spend the gains on goods and services which are themselves major users of fossil fuel.

The top 20% of British households spend almost nine times as much on transport costs as the bottom 20%. Give more income to the poorest fifth, and you can be reasonably confident that a large fraction will go on buying more transport, with substantial increases in emissions.

- The embedding of energy in economic growth.

Much conventional economics sees economic growth as arising from improvements in the productivity of capital and labour, as well as increases in the amount of capital equipment applied to productive activities. Because energy is only 4 or 5% of the economy, standard economic theory does not give much thought to the impact of energy efficiency. Rebound effects, direct or indirect, are not even mentioned by the IPCC or the Stern Review. Is this correct? Or is increasing energy use a vital part of the way in which modern economies grow? If this is the case, then trying to maintain world growth rates while cutting energy use represents an extraordinarily difficult problem.

The most revelatory paragraph in the Energy Research Centre study into the wide questions of rebound says as follows:

Taken together, the evidence reviewed in this report suggests that: a) the scope for substituting other inputs for energy is relatively limited; b) much technical change has historically increased energy intensity; c) energy may play a more important role in economic growth than is conventionally assumed and d) economy-wide rebound effects may be larger than is conventionally assumed.

Written in tentative and thoughtful academic language, the review is telling us that there is a possibility that improving energy efficiency will simply enhance the rate of global growth, drawing in more energy use. A possible conclusion from this ERC review is therefore that improved efficiency in energy use is bad for climate change.

This is frightening stuff. The implication is that it is doubly urgent to decarbonise energy sources for we cannot confidently expect that rates of growth of energy use are likely to fall below world GDP growth at any foreseeable future date.

## Biochar can sequester carbon cheaply

Organic matter, such as agricultural waste, heated in the absence of oxygen splits into two types of material: a charcoal (biochar), and hydrocarbon gases and liquids. When added to soils, the charcoal can provide a powerful fertiliser. The hydrocarbons can be burnt, either to generate electricity or to power an internal combustion engine.

Biochar is exciting growing attention around the world. Charcoal's ability to improve soils can sometimes be spectacular. But more importantly from a climate change perspective, charcoal is almost pure carbon and is strangely stable in soils. It seems to persist for centuries. Charcoal can therefore offer substantial opportunities for long-term sequestration of carbon. The valuable fuels from the biogases and liquids are also carbon-neutral since they contain CO<sub>2</sub> previously captured during photosynthesis. As a third major benefit, soils fertilised with charcoal seem to need less artificial fertiliser, thus saving fossil fuels. Fewer applications of fertiliser would reduce the level of emissions of nitrous oxide, a particularly dangerous greenhouse gas.

Biochar manufacture represents a way of productively storing large amounts of carbon. But the carbon in the charcoal could be burnt to generate electricity instead of being stored in soil. Current emissions trading schemes, such as the European ETS, do not allow sequestered carbon to be considered as equivalent to a reduction in greenhouse warming emissions. This is a mistake that will need to be rectified. It makes more sense to use agricultural land to make biochar and biogases/bioliquids than to burn the biomass in power stations. Power stations burning wood benefit from buying fewer emissions certificates and from the renewable energy subsidy, but there is no comparable benefit from storing carbon in the soil. This is an anomaly that should be removed.



\*\*\*

Some Amazonian soils are extremely rich and fertile. Thick and almost black, these soils contain a high percentage of very stable carbon. The pre-Columbian population appears to have fed their naturally thin soils with large amounts of charcoal which have remained until today. Known as 'terra preta' soils, they have remained fertile for hundreds of years after the application of carbon in the form of charcoal.

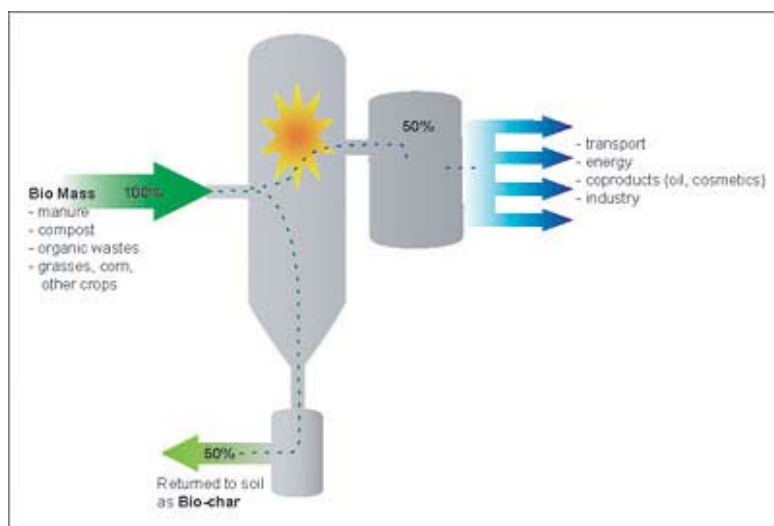
Researchers have noted that charcoals can improve soil productivity in other soils around the world. No one quite understands the process, and a great deal more scientific work needs to be done, but the evidence is strong that the highly porous structure of biochar helps retain other nutrients and provides a protective structure that encourages the growth of beneficial micro-fungi. Its sponge-like porosity gives it a huge surface area on to which nutrients and useful organisms can cling. Biochar that has been laced with applications of potassium and phosphorus appears to achieve even better results than the simple charcoal. (See <http://www.eprida.com/>.)

Established terra preta soils have high productivity. Yields can be more than twice those of adjacent areas to which charcoal has not been applied. From the point of view of improving soil fertility, it may make good sense to apply biochar to a large percentage of the world's soils.

### How to make biochar

Wood and other organic residues such as crop wastes can be burnt in air, and will leave a small amount of black charcoal. Most of the carbon in the organic matter is burnt, generating heat, carbon dioxide, and other gases. Unlike biochar, the carbon that is left unburnt tends to be quite quickly digested by the soil.

Heating in the absence of air is usually called 'pyrolysis'. (Much oven cooking occurs as pyrolysis. The external layer of the food seals the inside from oxygen.) During pyrolysis, the heat drives off hydrocarbon gases and liquids (as well as the remaining water). Eventually, all that is left is biochar, which can be almost pure carbon. The carbon at the end of the pyrolysis process can represent as much as 50% of the original weight of the organic waste. The percentage depends on the original material and on the temperature to which it was heated.



Pyrolysis can be carried out on a very small scale, producing charcoal and gases for cooking use. In the past, the charcoal would have been employed as an efficient source of heat for other uses, whether metal smelting or the cooking of food. The challenge now is to produce equipment that can handle hundreds of tonnes of bio-waste or wood residues every day. Some businesses are well on the way.

In today's pilot plants, the original organic material passes through sealed vessels to which heat is applied. This heat may be derived from burning the gases driven off in previous pyrolysis. The hydrocarbons are collected, either as gas or as liquid and the solid material is then cooled and crushed into very fine carbon granules.

Dynamotive in Canada and BEST Pyrolysis (Australia/US) are making good progress towards commercial-scale plants processing hundreds of tonnes of material a day. I don't doubt that large industrial-scale biochar manufacturing facilities will be successfully developed within three or four years. This area is already attracting substantial sums of private capital, and the technological challenges are not of the greatest difficulty. The crucial determinant of whether the sequestration of biochar becomes a large-scale worldwide activity is financial. Does it make sense to store charcoal in soil rather than burn it?

### The financial value of biochar

The short section that follows contains dense financial calculations. Its purpose is simply to say that:

- Emissions trading schemes should incorporate carbon sequestration in the soil as a valid reduction in CO<sub>2</sub>.
- The current UK system for subsidising renewable electricity generation is extremely generous to the burning of renewable fuels. The system offers a misplaced incentive to use charcoal to burn in power stations rather than store it in the soil, although the net effect on carbon emissions will be approximately equal.

For those interested, here are the numbers:

A tonne of good quality biochar has an energy value of about 28 gigajoules (GJ), slightly less than the best quality coal. (Pure black carbon is about 32 GJ/tonne.) Standard coal costs about £1.50 per GJ. If a power station operator is prepared to pay the coal-equivalent price, biochar is worth about £42 per tonne in the UK.

Burning a tonne of biochar will produce about three and a half tonnes of CO<sub>2</sub>. (Pure carbon would generate 3.667 tonnes.) The current price of CO<sub>2</sub> in the European Emissions Trading Scheme (ETS) is about £16, meaning that sequestering 3.5 tonnes ought to be worth approximately £56. Since £56 is greater than £42, the economic logic suggests that we should hold the carbon in the soil rather than burning it. This is before considering the secondary climate change benefits of reduced fertiliser use and lowered nitrous oxide emissions.

Of course, today it isn't yet possible to make the rational choice and plough biochar into the soil. The farmer cannot gain credit for sequestering organic matter in this way. The ETS doesn't recognise the storing of inert carbon as a valid way of reducing emissions. So charcoal gets burnt in the UK, rather than being stored. This needs to change: sequestering biochar in the soil is a reasonably inexpensive way of reducing net CO<sub>2</sub> emissions.

In fact, the position is far more illogical even than this. If a power station burns an 'energy crop', such as willow or miscanthus grass, it gets two Renewable Obligation Certificates per MWh generated, worth over £90. Per tonne of biochar used in a specialist biomass power station, such as E.ON's at Lockerbie, the power station operator will generate about 2.3 MWh, and therefore get ROCs to the value of over £200. [Carbon Commentary has written before about the excessive generosity of this arrangement – please see issue 1 of this newsletter.](#)

The net effect of the subsidy regime in the UK is that charcoal sequestration is financially unattractive before

considering the benefits in terms of reduced fertiliser use. But in terms of the underlying carbon saving, it would be better to plough the char into the soil.

### **Weighing the climate change benefit of smaller amounts of fertiliser**

Artificial fertilisers are bad for global warming because they take substantial amounts of natural gas to make, and because they seem to cause greater amounts of nitrous oxide to be emitted from fields and local watercourses as the fertiliser breaks down. Nitrous oxide has over 300 times the global warming effect of CO<sub>2</sub>. It may be that at least 2% of the nitrogen in fertiliser ends up in the form of nitrous oxide after being applied on a damp British field.

I have seen no complete studies of how much it might be possible to reduce fertiliser use by adding biochar to a field. But a few illustrative numbers might be helpful. A hectare of wheat gets about 200kg of fertiliser a year. The CO<sub>2</sub> cost of making this is something over 1 tonne. The nitrous oxide effect might triple this. In the ETS, four tonnes of CO<sub>2</sub> costs perhaps £64. So even if biochar meant that the farmer could completely get rid of fertilisers, it would still only have a small CO<sub>2</sub> benefit if all the emissions were valued at current prices. All available biochar would still probably be burnt for its value in ROCs.

The more interesting question is whether agricultural yields would go up. Terra preta soils succeed partly because they have much higher carbon content than other land in the same area. UK soils already have reasonable carbon content, so the impact of biochar is likely to be much less. We need further research on this urgently.

In Australia soil carbon levels are generally very low. There the value of adding biochar may be very much greater. Unsurprisingly, a good portion of the research into adding charcoal to soils is being carried out in Australian universities and companies.

### **Could sequestering biochar make a big difference to UK emissions?**

The answer to this question is quite complicated, but broadly speaking the answer is yes. Soil used to grow miscanthus grass can produce about 20 tonnes of organic matter per year. Burnt in a low temperature pyrolysis furnace, this grass will give off substantial amount of gas and liquids that can be burnt as fuel, reducing fossil fuel use. This has value, and replaces fossil fuel. About 10 tonnes of char might be left, producing 35 tonnes of CO<sub>2</sub> if it had been burnt, per hectare. To sequester 70 million tonnes of CO<sub>2</sub>, or somewhat over 10% of UK emissions per year, we would need to devote about 2m hectares to growing grasses or fast-growing willow for turning into charcoal. The UK has about 19m hectares of land in agricultural use of which over 7m is used as grassland. In other words, we probably could sequester the equivalent of 10% of our emissions every year, but it would need us to convert a lot of low-value grazing land to miscanthus. We'd get additional benefits from improved soil fertility, lowered fertiliser use, and the benefit of burning the biogas and bioliquid.

It is probably more important to get people in the tropics using biochar for soil improvement. Tropical agriculture often uses 'slash and burn' for clearing an area prior to cultivation. Changing this to 'slash and char' would sequester most of the carbon, and increase the number of years the soil could be used before the farmer moved to other land. The potential in the tropics for carbon sequestration is far greater than in high latitudes.

Biochar appears to have real significance as a technique for reducing emissions around the globe. The case for substantial investment in R+D, as well as changing the regulatory incentives to sequester carbon, is overwhelming.

(Readers interested in learning more about the worldwide research into biochar may like to go first to the web site of Cornell professor Johannes Lehmann, a leading figure in the scientific investigation: [http://www.css.cornell.edu/faculty/lehmann/terra\\_preta/TerraPretahome.htm](http://www.css.cornell.edu/faculty/lehmann/terra_preta/TerraPretahome.htm).)

## **Natural disasters and global warming**

The automatic assumption is now that weather-related natural disasters are linked to climate change. Politicians and administrators are quick to blame global warming, partly to distract attention from human incompetence. Two recent examples illustrate the point.

The terrible floods in Tabasco, Mexico have left 80% of the province under water. 800,000 people have lost their homes. All crops have been lost. Many places are flooded to a depth of 2m and it will be weeks before the water recedes.

40cm of rain fell in three days, almost twice the monthly average for October. The president of Mexico was quick to blame global warming for the deluge. But this part of the country is low-lying and has had very severe floods in the past. The severity of this episode may have arisen as much from the mismanagement of the local hydro-electric power plants



as from climate change.

The Californian wildfires destroyed about 600,000 acres of woodland. The cost of repair will be over \$1bn. State authorities blamed the strong Santa Ana winds (possibly connected to climate change), high temperatures, and the prevailing drought. The reality is more complex: American fire losses are tending to rise, but the California fires were more to do with poor forest management practices over the last decades than 'global warming'. Parts of California have had very little water this year, but North America regularly suffers from water shortages and this year's drought is no worse than at several other times in the last hundred years.

Climate change will almost certainly bring far higher temperatures, more drought, greater numbers of extreme rainstorms, rising sea levels and increased winds. But in the case of some recent catastrophes, the evidence to link the disaster to global warming is thin or debatable. Politicians and administrators worried that blame will be attached to them for past inaction are far too ready to shift responsibility to an amorphous global force. News media are very willing to fall unquestioningly in line. This sloppiness gives easy targets to the global warming deniers and makes generating international action more difficult, not less.

\* \* \*

### **Mexican floods**

The Mexican state of Tabasco is largely low-lying, marshy, and prone to flood. Several substantial rivers cross the state, draining the highlands to the south. Four major hydro-electric plants dam the important Grijalva River. The Penitas dam, built in 1987, is the furthest downstream.

In 1999, very heavy rains lasting much of September and October filled this dam. Then, as now, the storms were said to be the heaviest ever recorded but I could find no mention of climate change in the government's assessment of the weather eight years ago. Eventually, the flood gates of the Penitas dam had to be opened, putting the town of Villahermosa in Tabasco province under water to a depth of several metres. A large fraction of the inhabitants of the state were flooded out of their homes.

When emergency discharges need to be made to stop breaches or over-topping of a dam, the land downstream is likely to be saturated already. The surge of water will often cause flooding. The Penitas dam designers had predicted this problem in 1987 and insisted on measures to maintain the flow of water downstream and to allow for controlled local flooding. The *New York Times* of 25 October 1999 said 'the state government mapped the key drainage areas in 1987 and prohibited development in them'. The newspaper reported that the bans were ignored by local authorities and developers.

After the floods of 1999, money was allocated to flood protection works downstream from the Penitas dam. Reports in the wake of the 2007 disaster consistently say that these funds have not been properly spent.

When President Calderon visited the affected area last week he is reported as making the following statement: 'I can assure [local people] that the origin and cause of this catastrophe is enormous climate change'. The rains of late October 2007 were indeed intense: about 40cm fell in three days, far more than is expected in the month as a whole. It is probable that this would have caused major floods anyway. But the presence of the dams and the use of the flood plain for development and roads almost certainly made the situation far worse.

As the science writer Fred Pearce wrote in a report in 2001 for the World Wildlife Fund, the job of a hydro-electric dam is to generate power. The engineers want the dam to be full so that next year's dry season does not reduce the amount of electricity that can be generated. Severe conflict is inevitable between the urge to hold the valuable water for power generation and let it out to maintain spare capacity for holding future rainfall.

So even though October often brings heavy rains to this part of Mexico – and precipitation this year was predicted to be particularly heavy because of ocean temperatures – the dam operators would have been reluctant to let water out gradually prior to the crisis brought on by the torrential storm of 29 October-1 November. When the power company was ultimately forced to release water in a hurry, the land downstream was largely unprotected by the investments promised after the 1999 inundation. The further development of the flood plain since then made the eventual flooding worse than it otherwise might have been.

Climate change may or may not be responsible for the peculiar intensity of this year's rain. But President Calderon is wrong to suggest that the only cause of the disaster was global warming. Human failings, and the constant disputes between the state and federal governments, exaggerated the scale of the floods. 'Climate change' is simply too easy an excuse. The people of Mexico are convinced of the reality of climate change (see [Carbon Commentary Newsletter #2 and its article on the HSBC global opinion survey](#)) but in this case they seem to have ignored their president's glib assessment and blamed the dam and the electricity company that operates it.

### **Californian wildfires**

A long period of drought made southern Californian woodlands



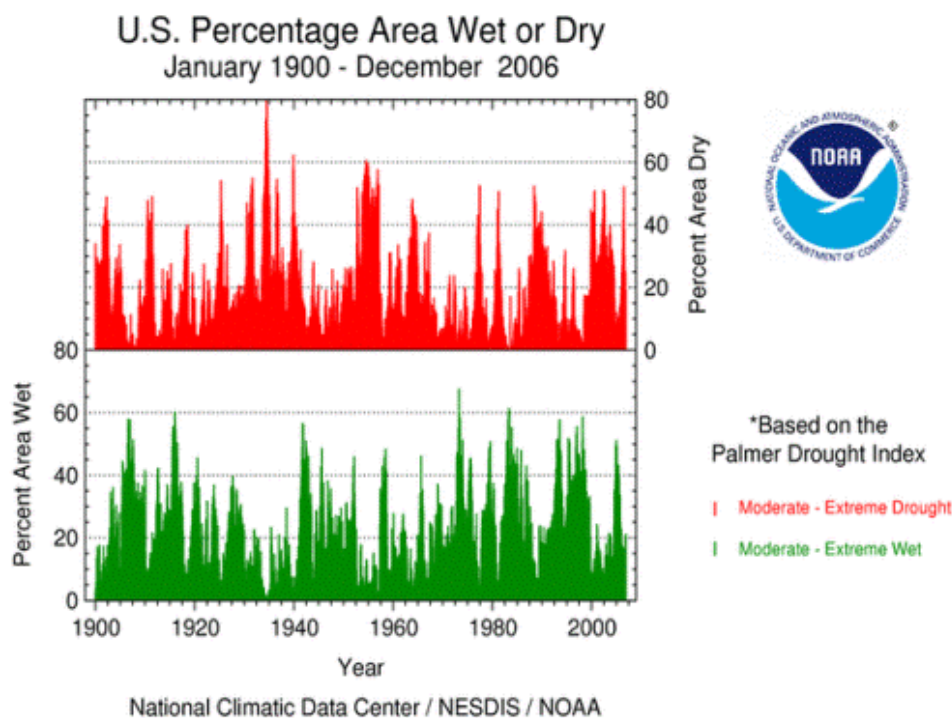
vulnerable to fire. Very little rain has fallen in this part of the US this year and temperatures have been relatively high – though not record-breaking. Several thousand fires, mostly very small, are quenched in California every year, but the size and rapid spread of this year's outbreak was particularly striking. Nevertheless, to put the issue in perspective, the fires in 2003 actually burned a larger area.



About 600,000 acres of woodland were lost, about 1% of the Californian forest total. The losses amount to about 6% of the 2007 area burnt in the US in 2007. This year is likely to be the worst on record for the US woodland losses, somewhat worse than the previous record of 2005.

The attention paid to the fires by the international media was largely driven by the extremely large number of people who were evacuated from their homes. The proximity of some of the fires to the homes of celebrities encouraged the coverage. Horrifying though the images were, the south-west United States is always susceptible to woodland fire, particularly at times of fierce Santa Ana winds, which fan any fire that starts and which may have contributed this year by blowing down live power cables.

Some commentators saw the fires as evidence of global warming. Though the intensity of the drought will have contributed to the rapid growth of these outbreaks, the US frequently sees drought. Chart 1 shows the pattern over the last hundred years, demonstrating that the 1930s were at least as dry as the last few years.



Though forest fire acreage may be increasing, the cause may not be global warming. Forest management techniques in the US strongly encourage the trend. The following quotation from an April 2007 US Environmental Protection Agency document makes the problem clear. It refers to the need to clear out substantial accumulations of dead wood in a Californian national forest. It says that 'fire exclusion' – the policy of stopping any fires, however small – is raising the risk of catastrophic burning:

A century of fire exclusion in the project area has resulted in overcrowded forest conditions and the loss of wet meadow habitat. Overcrowded conditions in forested areas have reduced tree vigor, reduced the proportion of hardwoods in forested areas and promoted the spread of root diseases. In the absence of fire, an understory of shrubs and small trees has developed which can act as a fuel ladder and carry fire into the forest canopy resulting in the loss of forest habitat. The lack of fire has resulted in accumulations of ground fuels which also increases the likelihood of flames reaching the canopy layer.

Until recently, US policy has generally been to stop any fires at all times in woodland areas. This has had the paradoxical effect of increasing major fire risk. Tree density is increased, dead undergrowth acts as tinder and sources of water are gradually overgrown by vegetation, reducing their effectiveness at restraining fire. The evidence is increasingly strong that the current policy is responsible for at least a large part of the increase in forest fires.

Increased suburban development close to forested areas exacerbates the problem. Impermeable surfaces increase the speed of run-off and reduce average soil moisture levels. Trees become drier. So although climate change may be responsible for higher temperatures in California and possibly create faster Santa Ana winds, the true reason for this year's fire outbreaks and their impact on homes is more to do with forest management policy and the spread of housing into dry forest areas. A sensible policy, as in Mexico and elsewhere, would be to accept that dangerous events are going to happen and plan housing and infrastructure development with unusual weather events in mind. As we see in the UK with our continued willingness to build in river floodplains, this is an easy policy to recommend, but more difficult to implement.

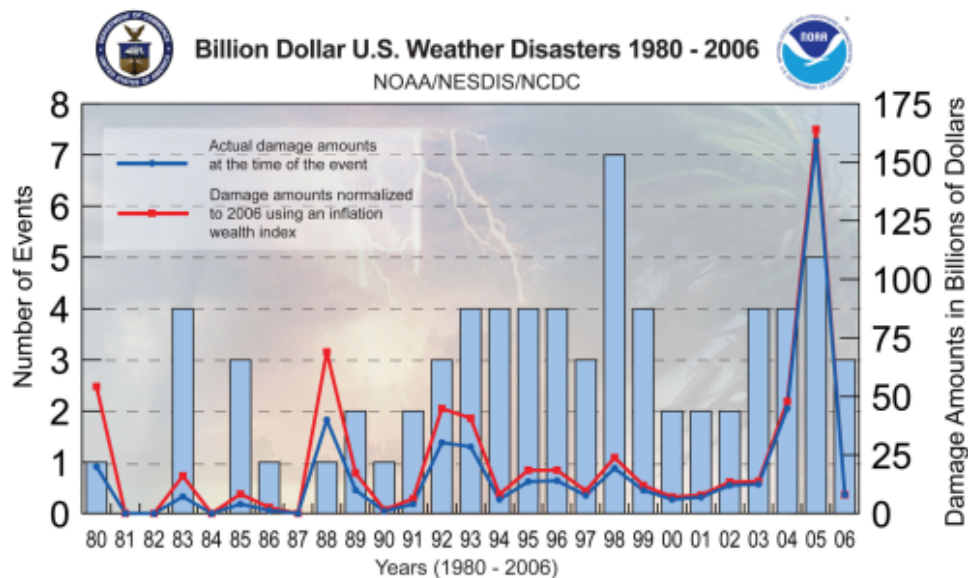
### Global climate-related disasters in 2007

Mexican floods and Californian fires have more complex causes than 'climate change'. They probably arise from the admixture of increasingly energetic weather systems and greater human intervention in the natural environment, as people demand better roads, larger houses, and more living space.

Across the world, this year has seen a large increase in natural disasters that appear to come, at least in part, from climate change. The United Nations said on 2 November that 140m have been affected by floods this year, of which about 100m are in China. The total is already four times last year's figure.

Another UN agency dealing with humanitarian relief has launched 15 'flash' appeals this year for emergency aid to a crisis in a developing country. Almost all of these appeals have been partly as a result of a climate-related event. In 2005, only six weather-driven appeals were made. This is probably a trend, but one cannot be sure. The new broom at the head of this UN agency may be more willing to ask for money, or it may be simply that humanitarian disasters are becoming more visible as a result of TV and the internet. The odds are quite high that the world is already seeing the impact of greater extremes of weather, but easy generalisation is dangerous.

Chart 2 shows the number and cost of 'billion dollar' weather disasters in the US. Is the number rising, or is it stable since 1990? No one can be completely sure, and human beings tend to need certainty before they will act. Unfortunately, the evidence on climate-related disasters is not quite at the required level of undeniability yet. Another bad excuse to do nothing.



**Companies mentioned in this newsletter: SAP, GM, Toyota, BBC, E.ON, Marks & Spencer, Dynamotive, BEST Pyrolysis.**

If you experience issues with the display of this newsletter, [click here](#) to view it in your web browser.  
If you do not wish to receive this newsletter, please send a blank email to [unsubscribe@carboncommentary.com](mailto:unsubscribe@carboncommentary.com).